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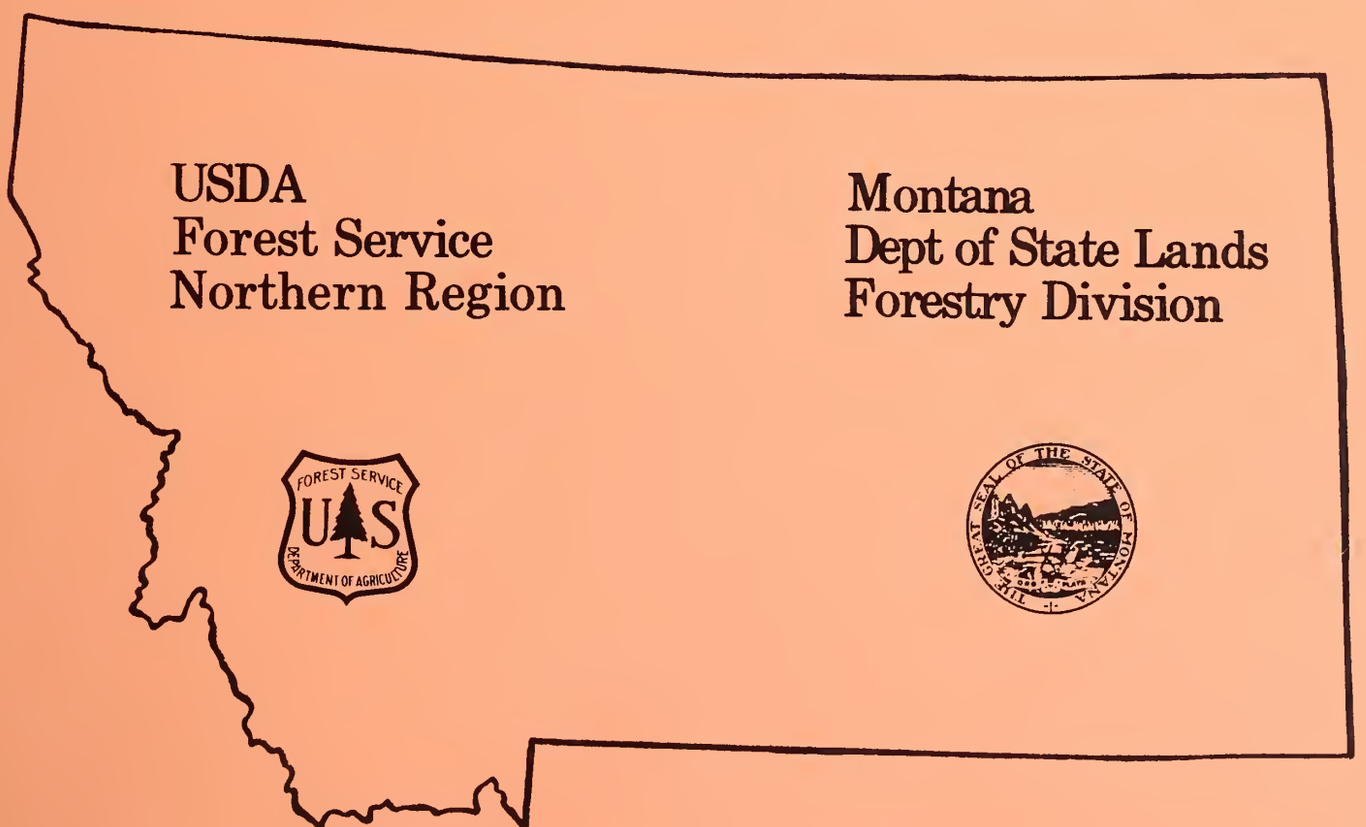

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MONTANA FOREST PEST CONDITIONS AND PROGRAM HIGHLIGHTS

1989

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Report 90-2

March 1990

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Forest Service, Northern Region
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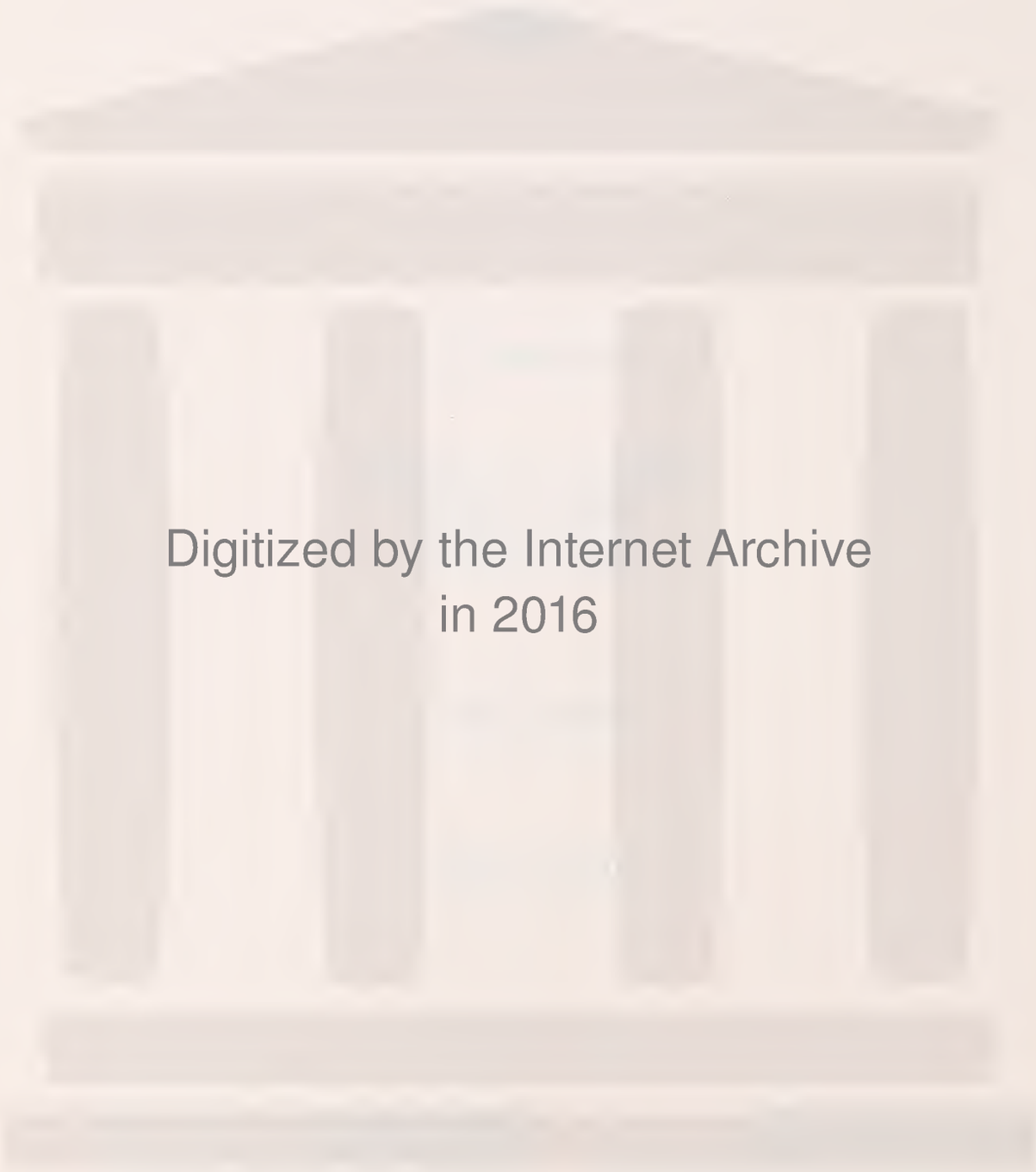
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INTRODUCTION

Prepared jointly by the Montana Department of State Lands Forestry Division and USDA, Forest Service Timber, Cooperative Forestry, and Pest Management (TCFPM), this report summarizes forest pest conditions present in Montana for 1989.

Data presented was obtained from aerial and ground surveys and on-site evaluations. The report details by ownership and acreage, the major pests (both insect and disease) found on forested land within the State. Cooperative training, directory of personnel, and recent publications are also included.

SUMMARY OF CONDITIONS

Insect and disease activity, which is a natural part of forest ecosystem dynamics, will continue to have significant impacts on the economic and forest health objectives of the Northern Region forests in the 1990's. The goal of land managers and insect and disease specialists has been to minimize this activity where it conflicts with society's objectives of timber production, recreation, watershed protection, and maintenance of wildlife habitat. However, in a dynamic state, forest ecosystems are constantly changing and evolving, ever-resisting attempts to keep them in a steady state of "health." This dilemma will continue to challenge forest resource specialists in 1990 and, indeed, throughout the coming decade. How we meet this challenge will help to determine the makeup, use, and health of our future forests in the Northern Region.

In 1989, our forests experienced significant, but declining, impacts on lodgepole and ponderosa pine as a result of mountain pine beetle activity. As was reported in 1988, this insect appeared to be continuing on a downward trend in 1989. The reduction in damage is attributable to population declines, which have occurred as a result of stand management practices and host depletion in many high-risk or susceptible stands. Predictions are for a continuation of the decline of damage associated with this pest in 1990.

Damage and loss of Douglas-fir in western Montana due to root rotting organisms, the Douglas-fir beetle, and recent drought conditions continues to be a source of concern. Activity of the fir engraver beetle on grand firs has increased substantially in 1989 (1,304 acres impacted) as compared to 1988 when only 104 acres were damaged. The root rotting organisms in the genera *Heterobasidion* and *Armillaria*, along with environmental stresses such as drought, appear to initiate attacks by these two beetles. If moisture levels improve in 1990, as they did in 1989, impacts from these two beetles should be lessened.

Western spruce budworm activity declined in 1989 by 43 percent. A large increase in activity did occur in the Bitterroot reporting area, however. Significant impacts on Douglas-fir, spruce, and true firs in the Region will likely continue, but based on this year's observations, a general decline in the overall population is anticipated.

The gypsy moth, although not established in Montana, continues to pose a serious threat, especially in riparian and western larch habitats. Based on recent larval feeding studies conducted at Oregon State University, many of our western conifers have the potential to act as suitable hosts for gypsy moth growth and development. Of these, Douglas-fir, western larch, and lodgepole and ponderosa pines are of greatest concern because they comprise a significant portion of the timber base in Montana's forests. Also at risk are the many miles of riparian habitat which have an abundance of *Salix spp.*, *Alnus spp.*, and *Populus spp.*; all favored host genera of the gypsy moth.

INSECTS

Bark Beetles

Mountain Pine Beetle

The mountain pine beetle (MPB), although continuing its general decline across the Region, continued to

have significant impacts across all ownerships in Montana (see following map). This aggressive beetle impacted a total of 386,224 acres of lodgepole pine, 32,465 acres of ponderosa pine, 1,915 acres of white bark pine, and 867 acres of western white pine (Tables 1 and 2). Lodgepole pine in the Kootenai reporting area received the greatest impacts with 265,641 acres affected across all ownerships. The continuing decline throughout the Region can be explained by a reduction in the amount of susceptible host material present as a result of stand management practices and beetle depredations. The greatest impacts associated with this pest usually coincide with an abundance of susceptible host stands which are overstocked and/or over-mature. Prolonged periods of drought or dry weather may act as a trigger for outbreaks in these stands. The years 1987 and 1988 were no exception. Conditions reported in this issue reflect beetle activity that essentially took place in those years. Attacks which have occurred in 1989 will not show up until 1990 or perhaps in 1991. Time lags between the first beetle attacks and the eventual fading or reddening of the foliage depend on tree resistance and environmental conditions. Although significant impacts from this serious forest pest will likely continue, populations are expected to continue their downward trend in 1990.

- **Beaverhead Reporting Area.** Across all ownerships, damage by MPB was up slightly from 1988 with a total of 580 acres impacted. This level of damage would indicate that populations are still at an endemic level. Of the total acreage impacted, 73 percent was located on Federal ownership, and the remaining 27 percent occurred on State and private lands. Ninety-eight percent of all infestations were located in lodgepole pine stands.

- **Bitterroot Reporting Area.** Attacks on ponderosa pine, across all ownerships, were up from 1988 estimates of 6,642 acres compared to 12,246 acres in 1989. Ponderosa pine on State and private ownerships exhibited the largest percent increase of attack at 52 percent, while Federal ownerships experienced a 30-percent increase. Attacks in other susceptible species were negligible.

- **Custer Reporting Area.** Although an increase in damage was recorded for 1989, beetle activity on the Custer continues to be low. A total of 32 acres were infested across all ownerships. Most of this was located on Federal ownerships, with attacks about evenly split between lodgepole pine (near Red Lodge, Montana) and ponderosa pine located on the eastern Ranger Districts.

- **Deerlodge Reporting Area.** Beetle damage decreased from 1988 levels by 74 percent on State and private lands, but increased by 37 percent on Federal ownerships. A total of 39 and 2,591 acres were attacked on State and private, and Federal ownerships, respectively. Lodgepole pine was the species of preference, but damage was also observed on white bark pine and incidentally on ponderosa pine.

- **Flathead Reporting Area.** Although large acreages (62,978) of pines were attacked across all ownerships, overall mortality was down significantly from that observed in 1988, when 109,087 acres were reported damaged. Acres infested declined by 37 percent on Federal lands, and by as much as 71 percent on State and private lands from 1988. The majority of attacks, 98 percent, occurred on lodgepole pine. Other species attacked were ponderosa, white bark, and western white pines.

- **Garnets Reporting Area.** Beetle activity on State and private lands declined by about 13 percent with 552 acres infested. Damage was almost entirely in ponderosa pine.

Areas of mountain pine beetle infestations in Montana and Yellowstone National Park (all host species), 1989.

Table 1.--Acres of Mountain Pine Beetle-Caused Mortality on Federal Lands in Montana and Yellowstone National Park (NP)--1988 and 1989.

	1988				1989			
Area	LPP1/	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	4	--	--	--	417	--	8	--
Bitterroot NF	--	2,399	1	--	44	3,397	--	--
Custer NF	--	2	--	--	13	18	--	--
Deerlodge NF	1,618	5	--	--	2,472	56	63	--
Flathead NF	93,106	39	98	109	57,375	19	799	254
Gallatin NF	--	--	--	--	89	--	--	--
Helena NF	1	8	--	--	5	8	78	--
Kootenai NF	304,785	6,306	21	458	248,033	10,636	327	484
L&C NF	1	179	--	--	46	98	--	--
Lolo NF	28,051	813	3	84	26,698	2,607	634	2
TOTAL NF	427,566	9,751	123	651	335,192	16,839	1,909	740
Glacier NP	--	--	--	--	1,085	--	--	52
Yellowstone NP	--	--	--	--	--	--	--	--
TOTAL NP	--	--	--	--	1,085	--	--	52
Blackfeet IR	--	--	--	--	--	--	--	--
Crow IR	--	3,635	--	--	--	1,228	--	--
Flathead IR	1,429	47	5	2	905	553	--	--
Ft. Belknap IR	--	--	--	--	--	1	--	--
N. Cheyenne IR	--	19	--	--	--	--	--	--
Rocky Boy's IR	--	--	--	--	4	1	--	--
TOTAL IR	1,429	3,701	5	2	909	1,783	--	--
TOTAL BLM	1,037	235	1	--	10	96	3	1
TOTAL FEDERAL	430,032	13,687	129	653	337,196	18,718	1,912	793

1/ LPP = Lodgepole Pine PP = Ponderosa Pine WBP = Whitebark Pine WWP = Western White Pine

- **Gallatin Reporting Area.** As was reported in 1988, the MPB remains at endemic levels with a total of 170 acres infested across all ownerships. Lodgepole was the preferred host species.

- **Helena Reporting Area.** Although damage caused by the beetles remains light, attacks have increased on all ownerships with a total of 297 acres reported. Lodgepole and ponderosa pine on State and private lands accounted for a significant portion (69 percent) of the total. Seventy-eight acres of white bark pine were also affected. None had been reported in 1988.

- **Kootenai Reporting Area.** As in the previous 2 years, damage caused by the beetle remained high in susceptible lodgepole pine stands with 265,641 acres affected across all ownerships. To a lesser extent, ponderosa pine was also attacked with 12,496 acres reported infested. Areas of greatest impacts were the Three Rivers, Fisher River, Fortine, and Libby Ranger Districts. Beetle populations in susceptible stands located in the Upper Yaak drainage show evidence of possible increase in activity for 1990. However, overall population trends for the last several years continue to show a decline in most areas across all ownerships. Estimates for 1987 and 1988 of affected acreages for all species and ownerships were 316,037 and 347,558, respectively.

Table 2.--Acres of Mountain Pine Beetle-Caused Mortality on State and Private Lands--1988-1989.

	1988				1989			
Area	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead	3	--	--	--	152	1	2	--
Bitterroot	--	4,243	--	--	2	8,849	--	--
Custer	--	--	--	--	--	1	--	--
Deerlodge	147	4	--	--	35	4	--	--
Flathead	13,643	2,088	--	4	4,429	42	--	60
Gallatin	--	--	--	--	80	--	1	--
Garnets	3	634	--	--	1	551	--	--
Helena	1	18	--	--	41	165	--	--
Kootenai	34,276	1,705	--	7	17,608	1,860	--	7
Lewis & Clark	--	425	--	--	6	722	--	--
Lolo	10,092	331	2	1	5,356	1,237	--	--
Stillwater SF	28,240	1	1	21	18,137	1	--	5
Swan River SF	4	--	5	5	--	--	--	2
Thompson River SF	5,921	391	--	--	3,181	314	--	--
TOTAL	92,330	9,840	8	38	49,028	13,747	3	74

1/ LPP = Lodgepole Pine PP = Ponderosa Pine WBP = Whitebark Pine WWP = Western White Pine

- **Lewis and Clark Reporting Area.** Affected acreage (872) decreased by about 20 percent on Federal ownerships, and increased by about 42 percent on State and private lands. This acreage compares to 605 acres in 1988.

- **Lolo Reporting Area.** Affected acreage (36,534) was down from 39,377 acres in 1988 across all ownerships. The reduction represents a 7-percent decrease, overall. Of this amount, infestations in lodgepole pine on Federal lands amounted to 26,698 acres, or about 73 percent of total acreage reported. Infested lodgepole pine on State and private lands accounted for 5,356 acres, or about 15 percent of the total.

- **Glacier National Park.** A total of 1,137 acres were damaged along the Middle Fork of the Flathead River in 1989. Of this amount, 1,085 acres were in lodgepole pine and the remaining 52 acres in western white pine.

- **Yellowstone National Park.** Beetle populations in susceptible stands continue to remain at very low levels. Scattered damage was detected in white bark pine near Mammoth in 1988, but no further activity in this area was observed.

- **Blackfeet Indian Reservation.** As was the case in 1988, no infestations were observed during the survey. Beetle populations remained at endemic levels. Susceptible lodgepole pine stands remain on the western portion of the Reservation, however.

- **Crow Indian Reservation.** Beetle damage continues to decline from 3,635 acres affected in 1988 to 1,228 acres in 1989. All reported attacks were on ponderosa pine. This decrease represents a 66-percent reduction in activity for 1989.

- **Flathead Indian Reservation.** Infestations continued their decline in lodgepole pine stands with 905 acres reported in 1989. Damage caused by the beetle increased, however, in ponderosa pine upwards from 47 acres reported in 1988 to 553 acres in 1989. Activity on other susceptible species was not observed.

- **Fort Belknap Indian Reservation.** As was the case in 1988, beetle populations on the Reservation remained at an endemic to very low level. Only 1 acre of damage was reported.

- **Northern Cheyenne Indian Reservation.** No infestations were observed in 1989. This is in sharp contrast to beetle damage in ponderosa pine recorded in 1985 and 1986 when 2,800 acres and 2,500 acres were infested, respectively. Only 19 acres were reported attacked in 1988.

- **Rocky Boy's Indian Reservation.** Beetle populations remained at endemic to very low levels, with only 5 acres of attacks observed this year.

- **Stillwater State Forest.** Beetle damage continued to decline this year with 18,143 acres reported attacked compared to 28,263 acres in 1988. Ninety-nine percent of this activity occurred in susceptible lodgepole pine stands.

- **Swan River State Forest.** As was the case in 1988, populations remained at endemic to very low levels. Only 2 acres of western white pine were reported infested.

- **Thompson River State Forest.** Beetle populations have fluctuated within the last 4 years in susceptible lodgepole and ponderosa pines. This year, damage was down in lodgepole pine with 3,181 acres reported infested. The reduction of activity in lodgepole represents a 46-percent decrease, overall. Beetle damage in ponderosa pine exhibited a slight decrease with 314 acres impacted, which represents a 20-percent decrease in beetle damage overall from 1988 estimates.

Douglas-fir Beetle

This year's aerial survey revealed 6,295 acres of Douglas-fir damage/mortality caused at least in part by this beetle across all ownerships (Table 3). This compares to the 2,548 acres reported in 1988. Root disease along with prolonged periods of dry weather and drought the past several growing seasons has contributed greatly to these figures in 1989. Moreover, in 1987 and 1988, increases in populations had been observed. This year's ground surveys, however, indicate low brood survival and very few new attacks. Recent increases (1989) in moisture levels may have helped to reduce Douglas-fir susceptibility to attack by resident beetle populations. As a result, overall reported infestations should be down significantly in 1990.

Spruce Beetle

As was reported in 1988, spruce beetle damage remains very low. Only 5 acres were reported infested across all ownerships in 1989 (Table 3).

Pine Engraver

Acreage estimates of damage were up significantly for the reporting year. A total of 544 acres were infested, compared with 75 acres in 1988 (Table 3). Seventy-six percent of this damage occurred on Federal lands, and the remainder occurred on State and private ownerships. Again, drought is thought to play a significant role in predisposing pines to beetle attack. Moisture levels were up and new attacks were down in 1989, and as a result, 1990 beetle populations should be lower.

Table 3.--Acres of Bark Beetle-Caused Mortality (Other than Mountain Pine Beetle) in Montana and Yellowstone National Park--1989.

	Douglas-Fir Beetle		Engelmann Spruce Beetle		Pine Engraver		Western Pine Beetle		Western Balsam Bark beetle		Fir Engraver	
Reporting Area	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF	Fed.	S&PF
Beaverhead NF	5,142	38	--	--	--	--	--	--	139	14		--
Bitterroot NF	224	6	1	--	--	25	1	--	4	--	--	--
Custer NF	2	--	--	--	16	2	--	--	1	--	--	--
Deerlodge NF	1	21	--	--	--	--	--	--	5	61	--	--
Flathead NF	5	21	1	--	--	86	--	--	4	--	--	--
Gallatin NF	--	--	--	--	--	--	--	--	100	222	--	--
Garnets	--	1	--	--	--	--	--	--	--	568	--	--
Helena NF	1	--	--	--	101	3	--	--	--	--	--	--
Kootenai NF	99	3	1	--	--	6	--	--	9	1	25	--
Lewis & Clark NF	4	1	--	--	260	6	--	--	87	--	--	--
Lolo NF	679	33	1	1	--	--	152	102	490	--	895	289
Glacier NP	--	--	--	--	--	--	--	--	--	--	--	--
Yellowstone NP	--	--	--	--	--	--	--	--	--	--	--	--
Blackfeet IR	--	--	--	--	--	--	--	--	--	--	--	--
Crow IR	--	--	--	--	--	--	--	--	--	--	--	--
Flathead IR	7	--	--	--	34	--	--	--	1	--	1	--
Ft. Belknap IR	--	--	--	--	--	--	--	--	--	--	--	--
N. Cheyenne IR	--	--	--	--	5	--	--	--	--	--	--	--
Rocky Boy's IR	--	--	--	--	--	--	--	--	--	--	--	--
BLM	--	--	--	--	--	--	--	--	--	--	--	--
Stillwater SF	--	--	--	--	--	--	--	--	--	--	--	--
Swan River SF	--	--	--	--	--	--	--	--	--	--	--	--
Thompson River SF	--	7	--	--	--	--	--	--	--	--	--	94
TOTAL	6,164	131	4	1	416	128	153	102	840	866	921	383

Western Pine Beetle

This insect is capable of producing multiple generations in a single year. As such, it can rapidly exploit favorable habitat conditions often associated with periods of prolonged dry weather. When such conditions occur, they play a significant role in this insect's ability to successfully attack otherwise healthy trees. Acreage impacted by this beetle was up substantially over that reported in 1988, but as was the case with the pine engraver, new attacks in 1989 were down in most areas sampled. A total of 255 acres were damaged across all ownerships (Table 3), compared to 1 acre in 1988. Improved moisture conditions in 1989 may affect 1990 populations negatively.

Western Balsam Bark Beetle

This beetle is the most destructive species in its genus. Beetle activity was up significantly in 1988 and resulted in an increase of infested acreage detected this year. A total of 1,706 acres were reported damaged across all ownerships in 1989 (Table 3). This compares dramatically with the 21 acres reported in 1988. Root disease and other beetles along with drought conditions the past several years probably contributed to the increase in activity in 1988. Future infestations should decline if moisture levels improve in 1990 as they did in 1989.

Fir Engraver

Aerial surveys indicated significant impacts from this pest in 1989 with 1,304 acres damaged across all ownerships (Table 3). Previously in 1988, only 104 acres were reported infested. Again, the data reflects beetle activity that occurred in 1987 and 1988, and signs of that activity were recorded in the current survey. Of this year's total, 71 percent was located on Federal ownerships and the remaining 29 percent on State and private lands. About 91 percent of these attacks were located in the Lolo reporting area.

Defoliators

Western Spruce Budworm

Acres of aerially visible defoliation by western spruce budworm on all ownerships in Montana totaled 1,191,951 in 1989, a decrease from the 2,063,995 acres defoliated in 1988 (Table 4). Increases in defoliated acres were observed in the Beaverhead, Bitterroot, Garnets, and Lolo reporting areas (see following map). The largest increase occurred in the Bitterroot reporting area, where defoliation was 122,842 acres in 1989, compared to 8,926 acres in 1988. Acres of defoliation doubled in the Garnets and Lolo reporting areas.

Very significant decreases in acres defoliated occurred in the Helena reporting area, where 1,027,059 acres were defoliated in 1988, but only 124,306 acres in 1989, and the Lewis and Clark reporting area which dropped from 172,085 acres in 1988 to 10,783 acres in 1989.

Douglas-Fir Tussock Moth

Defoliation by Douglas-fir tussock moth of ornamental blue spruce was observed in Montana in 1989. Pheromone trap catches of adult male moths at 33 permanent trapping sites in Montana were at the lowest levels recorded in the past 10 years that Douglas-fir tussock moth populations have been monitored by this method. No defoliation of forest trees was observed in Montana in 1989.

Gypsy Moth

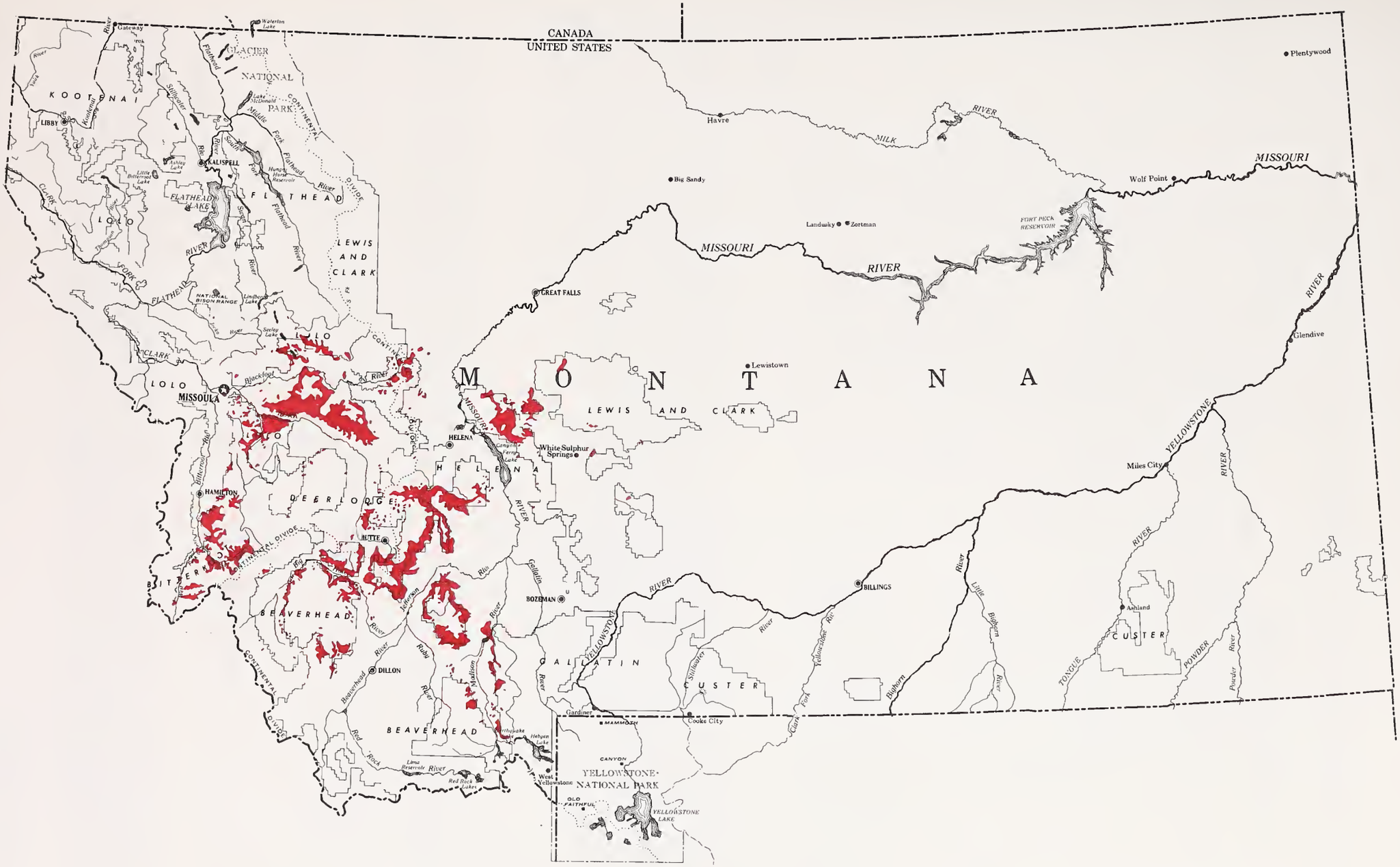
APHIS and cooperators (USFS, Montana Department of Agriculture, and Montana Department of State Lands) placed approximately 1,385 gypsy moth detection traps in Montana in 1989. Areas covered by trapping included cities, towns, State parks, National parks, campgrounds, and along major highways. Only one moth was caught in 1989; in a trap located in Great Falls. In the adjacent States of Idaho and Wyoming, moths were caught in Sandpoint, Coeur d'Alene, Idaho Falls, and Yellowstone National Park. Detection trapping efforts will continue in Montana for 1990. A large infestation (approximately 20,000 acres) currently exists in Utah.

Forest Tent Caterpillar

Defoliation by forest tent caterpillars decreased in areas of western Montana that were infested in 1988. Substantial increases in defoliation were observed in aspen stands on the east side of Glacier National Park, both within the Park and on private lands outside the Park. Few egg masses were found in these defoliated areas, indicating that population levels and resulting defoliation will decline in 1990.

Pine Butterfly

Population increases that were expected in 1989 in the Skalkaho Creek and Lost Horse Creek drainages south of Hamilton did not occur. However, populations of pine butterfly on ponderosa pines were high on private lands in the Lost Lake area southeast of Polson. Observations of overwintering eggs indicated populations will again be high in 1990, with the possibility of some visible defoliation.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Red Rock Lakes

Table 4.--Acres of Visible Western Spruce Budworm Defoliation on all Ownerships in Montana--1988 and 1989.

	All Ownerships		1989 Acres by Ownership			
Reporting Area	1988	1989	NFS	BLM	State	Private
Beaverhead NF	205,530	228,884	155,452	34,795	6,670	31,967
Bitterroot NF	8,926	122,842	103,160	--	6,327	13,355
Deerlodge NF	469,122	345,404	178,683	55,642	12,493	98,586
Flathead IR	--	91	91	--	--	--
Gallatin NF	39,704	--	--	--	--	--
Garnets	90,157	233,065	--	52,548	21,300	159,217
Helena NF	1,027,059	124,306	61,891	4,039	3,803	54,573
Lewis & Clark NF	172,085	10,783	9,617	--	--	1,166
Lolo NF	51,412	126,576	78,625	1,764	9,220	36,967
TOTAL	2,063,995	1,191,951	587,519	148,788	59,813	395,831

Leafroller

The leafroller, *Archips negundanus* (Dyar) (Parker and Moyer 1972), has become an important defoliator of boxelder, *Acer negundo* L., in portions of Montana. Severe defoliation occurred on nearly every boxelder in the City of Missoula in 1989. The insect overwinters in the egg stage with larvae hatching in early spring. Tree defoliation is noticeable by late June and early July. By then, the larvae have completed their development. They pupate and emerge as adults in July and August. There is only one generation per year. Many boxelder trees that were defoliated in spring and early summer re-foliated later in the summer (Figure 3a and 3b). Larvae and pupae reared to adults in the laboratory indicated a 70-percent survival rate. Defoliation is expected to continue in 1990.

DISEASES

The most damaging disease problems in Montana are widespread and chronic, continuing to cause problems in the same areas every year (e.g. root diseases, dwarf mistletoes, and white pine blister rust). The status of these diseases remains fairly constant from year to year, so they are not monitored by aerial surveys.

The narrative below discusses disease problems that significantly changed in status during 1989. Other chronic diseases that occur in Montana are described in Table 5. The narrative also discusses the status of various pathology projects and any recent results.

Review of New Disease Developments

Winter Injury

During the winter of 1988 - 1989, unusually severe weather fluctuations occurred throughout much of Montana causing extensive damage to many coniferous forests (Figure 4a and 4b). Very mild weather was followed by severe cold weather in which wind chill temperatures dropped to -70°F and below in many areas. Symptoms included various combinations of needle browning and bud and branch death. The most signifi-

Figure 3a. A boxelder tree defoliated by *Archips negundanus*. Photo taken July 7, 1989.

Figure 3b. The same tree re-foliated a month later. Photo taken August 6, 1989.

Figure 4a. Winter damaged lodgepole pine, Helena National Forest.

Figure 4b. Close-up of winter damaged lodgepole pine, Helena National Forest.

cant tree damage occurred on the Helena, Deerlodge, and Lewis and Clark National Forests. Less and more widely scattered damage occurred elsewhere. A total of 433,000 acres showed aerially visible injury with about 111,000 of those classified as heavily injured. Lodgepole pine was the species most affected. Lesser amounts of damage occurred to ponderosa pine, Douglas-fir, western white pine, western larch, Engelmann spruce, and subalpine fir. A survey was initiated that will be continued in 1990 to assess the permanent effects of this injury.

Larch Needle Blight

Damage from larch needle blight was down this year from previous years. Discolored western larch were scattered throughout northwestern Montana with some areas of heavy infection near Hungry Horse Reservoir on the Flathead National Forest and south of Libby on the Kootenai National Forest.

Dutch Elm Disease

Dutch elm disease continued to cause a substantial economic impact in some Montana cities in 1989. Great Falls began sanitation efforts and infected tree removal in 1987, when 384 American elms were removed. In 1988, 637 elms were removed and in 1989, 2,309 elms were removed. Total infected American elms removed from Great Falls for the 3-year period were 3,330, which represented a loss of 28 percent of the American elms in the city. Tree losses are expected to be very high again in 1990.

In Billings, where an active sanitation program has been operating for more than 10 years, approximately 200 trees were removed in 1989. Since 1979, almost 5,000 infected American elms have been removed from this city.

Nursery Diseases

Storage mold. Molding was observed in some bareroot Douglas-fir seedlings lifted in the fall of 1988, stored over the winter, and scheduled for planting in the spring of 1989. Most seedlings are now stored for extended periods within facilities at individual Ranger Districts. Although the goal is to maintain storage temperatures below 0°C, in some cases, temperatures exceed freezing, particularly during transit and handling. Mold fungi can grow and proliferate at temperatures slightly above freezing. Many of these fungi are introduced into stored seedlings on soil that gets distributed on foliage during packing.

Fusarium root diseases. Fusarium diseases are usually controlled in bareroot nurseries by soil fumigation. Basamid® granular has recently been used at the Champion Timberlands Nursery in Plains and the Montana State Nursery in Missoula. This chemical is effective in reducing populations of potential pathogens, but does not penetrate soils as deeply as methyl bromide/chloropicrin (which was previously used at both nurseries) and may be phytotoxic to nearby seedlings, especially western white pine.

Recent evaluations have shown that contaminated styroblock and pine cell containers are often important sources of *Fusarium* inoculum. Standard steam cleaning usually does not adequately reduce this contamination. However, immersion in hot water (68°C for 10 minutes) was effective in greatly reducing *Fusarium* contamination of styroblock containers. Sodium metabisulfite has also shown promise, particularly at a 5-percent concentration in which containers are dipped for 30 seconds. Effects on seedling production is unknown, but will be determined.

An evaluation to determine fate of *Fusarium* on the roots of outplanted container-grown Douglas-fir seedlings has indicated that *Fusarium* spp. are still detectable on seedling roots even after three growing seasons. However, these fungi were mostly limited to the old "plug" roots and were not detected on new roots which had egressed from plugs.

Review of Pathology Projects

Annosus Root Disease

A new project was initiated in 1989 to examine the occurrence and potential role of annosus root disease in Douglas-fir/grand fir stands on the Nez Perce National Forest. Blakey Lockman will carry out this project. Blakey is in a cooperative education program with TCFPM earning her Masters Degree at Oregon State University.

Armillaria Root Disease

Permanent plots were established in 1984 and 1985 in 23 young stands in northern Idaho and western Montana. The objectives of the plots were to determine species susceptibility to Armillaria root disease, and the effects of precommercial thinning on disease-caused mortality. The plots were remeasured in 1989.

Plots in the Hell Roaring Creek stand on the Flathead Indian Reservation received an 8-year evaluation. Sixty percent of the Douglas-fir in this commercially thinned stand have died from root disease since thinning in 1979.

Armillaria/Laminated Root Rot

A survey of the Lolo National Forest showed that nearly 20 percent (123,255 ha) of the commercial forest contained Armillaria and/or laminated root disease. A risk-rating system predicted a high probability of root disease in grand fir and western hemlock habitat types (59 percent), and in other habitat types on moderate slopes with southerly aspects (48 percent). In much of this area, fire control and selective cutting have created dense stands of mostly Douglas-fir and true firs which are now being infected with high amounts of root disease.

Plots in the Lonesome Creek Area of the Idaho Panhandle National Forests in thinned and unthinned commercial stands received a 15-year remeasurement and will be analyzed for effects of commercial thinning on root disease. About 55 percent of the Douglas-firs and 30 percent of the grand firs died during the period.

Plots in the Alder Creek area of the Idaho Panhandle National Forests have been monitored annually for 6 years. They were commercially thinned this year and will be monitored to evaluate the effects of thinning on root disease mortality.

Root Disease Model

The root disease model is now fully operational for northern Idaho stands. It has had substantial updates, improvements, and revisions, and will be added to the latest version of Prognosis (6.0), to be released in the spring of 1990. Default values used to describe rate of spread, etc., have been adjusted and saved in a default value file. Additional documentation will be developed and additional assistance will be available through the TCFPM office, Missoula. In areas where root disease is a problem, the root disease model predicts very different results from the Prognosis projections. The root disease model predictions appear to be more realistic.

The root disease model was used as part of an EIS prepared for the Wolf Creek drainage area of the Fernan District, Idaho Panhandle National Forests. The drainage was being evaluated largely for watershed resource management concerns. Watershed models were used to describe runoff and stream degradation during "rain on snow" events, taking into account the amount of canopy reduction in the drainage. However, this drainage is heavily infected with root disease. The root disease model showed that if no action is taken to manage the root disease, the amount of canopy reduction would increase over time and probably increase the problem of runoff and stream degradation. This is the first time that the root disease model has been used to provide impact statement inputs for resources other than timber.

There are plans to also use the root disease model for area analysis being planned for an area on the Wallace Ranger District, Idaho Panhandle National Forests.

White Pine Blister Rust

A new publication on the management alternatives for white pine blister rust is available through the Regional Office in Missoula. This publication gives the most current information on site-specific management alternatives for western white pine stands in Idaho and Montana. Topics of discussion include the concept of rust hazard and its application and approaches to using rust resistance and intermediate stand treatments.

Twenty-six western white pine plantations were surveyed for the purpose of monitoring how well blister rust resistance is holding up in the field. One plantation which had been planted with F1 stock was nearly a complete failure. It was the second time the stand had been planted with F1 stock with the same results. Evaluation showed that the rust hazard for this stand was too high for this level of resistance. The stand should have received F2 stock, or should not have been planted with western white pine at all. This case reinforces the importance of hazard rating stands to determine if it is appropriate to plant western white pine on a site, and if so, what level of resistant stock should be used.

Pruning and canker excising are increasingly being used as a management tool for bringing young western white pine stands through to merchantable size. Rust status surveys were conducted on several hundred acres of 15- to 30-year-old white pine stands. These surveys lead to pruning and excising in about one-third of these stands.

Work will continue in the selection and screening of blister rust resistance in white pine seedlings. This work will focus on the concentrated spore suspension method of seedling inoculation.

Dwarf Mistletoes

Permanent plots were established in 1970 and 1971 with the objective of studying the effects of different thinning spacings on the spread and intensification of Douglas-fir and lodgepole pine dwarf mistletoe. The lodgepole pine mistletoe plots on the Gallatin National Forest received a 5-year remeasurement. The level of dwarf mistletoe infection on these plots remained low, and no growth losses as a result of the disease have occurred.

A project is being initiated west-wide to obtain data needed for the development of dwarf mistletoe models. This project will involve the evaluation of currently available permanent plot systems, and the establishment of plots in areas where data needs are identified.

A new publication is available from the Rocky Mountain Experiment Station on the management of lodgepole pine dwarf mistletoe (RM-169). This publication is a thorough compilation of the literature of the disease and covers some new information on the biology of the parasite.

Table 5. Chronic Disease Problems in Montana.

MOST IMPORTANT DISEASES

Disease	Host	Remarks
Armillaria Root Disease	Douglas-Fir Grand Fir Other Conifers	Widely distributed, especially west of the Continental Divide. This is the most damaging root disease in western Montana. Infected trees are often attacked by bark beetles.
Laminated Root Rot	Douglas-Fir Grand Fir Other Conifers	Occurs throughout the range of grand fir in northwestern Montana. Is known to be particularly damaging on the Lolo and Kootenai National Forests. Infected Douglas-firs and grand firs are often attacked by bark beetles.
Dwarf Mistletoes	Lodgepole Pine Douglas-Fir Western Larch	Dwarf mistletoes are widespread throughout the state and one of the leading causes of forest damage. Dwarf mistletoe-caused growth losses are estimated to be about 33 $Mft.^3$/year. Lodgepole pine mistletoe occurs throughout the range of lodgepole pine. Douglas-fir mistletoe is scattered throughout the range of Douglas-fir west of a north-south line roughly 25 miles east of Missoula. Western larch mistletoe occurs throughout the range of western larch in western Montana.
White Pine Blister Rust	Western White Pine Whitebark Pine	Precludes the management of wild western white pine on all but low hazard sites throughout the range of western white pine. Rust resistant white pine has been successfully planted on the Lolo, Kootenai, and Flathead National Forests. Whitebark pine damage varies from minor to severe. Severe damage to whitebark pine is of concern in the Glacier National Park ecosystem because the species is an important source of food for grizzly bears.
Indian Paint Fungus	Grand Fir Western Hemlock	Occurs throughout the range of hosts. This fungus is the major cause of defect in mature true fir and hemlock in western Montana. A model that predicts volume losses due to Indian paint fungus will be tested for applicability in Montana.

Table 5. Chronic Disease Problems in Montana Cont.

DISEASES OF MINOR AND/OR LOCAL IMPORTANCE

Stem and Branch Diseases

Aspen Canker and Trunk Rot	Aspen	Are common in most aspen stands in Montana, particularly east of the Continental Divide.
Atropellis Canker	Lodgepole Pine	Found in pockets in pole-sized stands causing defect, topkill, and some mortality. Localized heavy infections are known to occur in western Montana.
Comandra Rust	Lodgepole Pine	Causes growth loss, deformity, and mortality. Can be locally important in lodgepole and ponderosa pine stands. Especially severe in lodgepole in south-central Montana.
Cytospora Canker	Sub-Alpine Fir Douglas-Fir	Occurs throughout the range of hosts. Causes branch flagging in large trees and dead tops and mortality in seedlings and saplings. Large trees may be predisposed to bark beetle attack or killed directly following drought stress.
Diplodia Blight	Ponderosa Pine	Causes stunting and mortality of new shoots. Severe infections may lead to death of the tree in association with bark beetle attack. Diplodia is widespread throughout Montana, and locally severe at several locations.
Pini Rot	Western Larch Pines Douglas-Fir True Firs Spruce	Serious decay problem in mature conifers.
Stalactiform Rust	Lodgepole Pine	Causes growth loss, topkill and mortality. Can be locally severe, especially in the Gallatin National Forest and some stands in the Beaverhead National Forest.
Western Gall Rust	Lodgepole Pine	Causes stem and branch galls and mortality in small trees. Occurs throughout range of hosts. Infection levels are highly variable.

Root Diseases

Annosus Root Disease	Ponderosa Pine Sub-Alpine Fir Other Conifers	Is common in ponderosa pine stands west of the Continental Divide. Is especially severe on the Flathead Indian Reservation.

Table 5. Chronic Disease Problems in Montana Cont.

Black Stain Root Disease	Douglas-Fir Lodgepole Pine Ponderosa Pine	Has been found in relatively few locations in the state, all of which are west of the Continental Divide.
Schweinitzii Root Rot	Douglas-Fir Other Conifers	Occurs throughout the range of hosts. Causes extensive root and butt rot, especially damaging in stands more than 80 years old.
	Foliage Diseases	
Elytroderma Needle Cast	Ponderosa Pine	Fungus infects the needles and causes brooming. Usually causes little damage, but severe, chronic infections can cause deformation and occasional death of small trees. Known to be locally severe in the Bitterroot Valley and around Flathead Lake.
Larch Needle Blight and Needle Cast	Western Larch	Occur throughout the range of the host. Needles are killed and growth loss can result from severe infections in successive years.
Rhabdocline Needle Cast and Swiss Needle Cast	Douglas-Fir	Occur throughout the range of host, and are quite common in northwestern Montana. Infected needles are killed and shed. Can cause economic damage in Christmas trees.
	NURSERY DISEASES	
Cylindrocarpon Root Disease	Conifer Seedlings White Pine	This fungus is capable of rapidly decaying roots, particularly of container stock. Severely infected trees may not display disease symptoms, but they are discovered when seedlings are pulled from containers. The fungus is introduced on infested seed or in contaminated containers.
Fusarium Root Disease	Most Damaging on Douglas-fir Western Larch Engelmann spruce	Root disease and damping-off caused by this fungus are two of the most important nursery diseases in Montana. This disease is damaging in both bareroot and container operations. The fungi are common inhabitants of nursery soil and are introduced on infected seed and contaminated containers.
Grey Mold	Container Grown Western Larch Engelmann Spruce	Occurs at some level during most years at many nurseries in Montana. Cultural and non-chemical strategies have been developed to reduce damage. Some fungicides are still necessary at certain times, and pathogen populations should be monitored for pesticide resistance.

Table 5. Chronic Disease Problems In Montana Cont.

Phoma Blight	Pines	Has been detected at several bareroot nurseries. The fungus is a common soil inhabitant and can be deposited on seedling foliage during rain or irrigation. Causes top dieback.
Pythium Root Disease	Most Conifers	Common soil-borne pathogen, especially damaging in poorly-drained soils where seedlings are stressed. Controlled by soil fumigation, but the fungus often rapidly reinvades the soil.
Sirococcus Shoot Blight	Pines	Occurs at low levels on bareroot seedlings at nurseries in western Montana. Outbreaks have occurred at several nurseries in the past.

COOPERATIVE TRAINING

After reviewing the current status of the insect and disease training program, we have decided that it is time to change the training format to better serve the needs of our participants. Rather than offering separate identification and management sessions, as was done in the past, a new course will be offered that covers identification and basic management strategies in one combined and expanded session. In addition to this combined course, a series of advanced and detailed management workshops will be offered that will present new and innovative techniques, strategies, or philosophies that have been developed in the past few years, and will offer intensive discussion and training in these areas.

The training schedule for 1990 is as follows:

Combined Insect and Disease Training:	Kalispell, June 4-8 Coeur d'Alene, June 11-15
Advanced Sessions:	To be announced

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COMMON AND SCIENTIFIC NAMES

	Insects
Douglas-fir beetle	*Dendroctonus pseudotsugae* Hopkins
Douglas-fir tussock moth	*Orygia pseudotsugata* (McDunnough)
Forest tent caterpillar	*Malacosoma disstria* Hubner
Gypsy moth	*Lymantria dispar* (Linnaeus)
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins
Pine engraver	*Ips pini* (Say)
Spruce beetle	*Dendroctonus rufipennis* (Kirby)
Western balsam bark beetle	*Dryocoetes confusus* Swaine
Western spruce budworm	*Choristoneura occidentalis* Freeman
Western pine beetle	*Dendroctonus brevicomis* LeConte
Fir engraver	*Scolytus ventralis* LeConte
Leafroller	*Archips negundanus* (Dyar) (Parker and Moyer 1972)
Pine butterfly	*Neophasia menapia* (C. and R. Felder)
	Diseases
Annosus root disease	*Heterobasidion annosum* (Fr.) Bref.
Armillaria root disease	*Armillaria ostoyae* (Romagn.) Herink
Atropellis canker	*Atropellis piniphila* (Weir) Lohm. and Cash
Black stain root disease	*Ceratocystis wageneri* Goheen and Cobb
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.) Pat.
Comandra rust	*Cronartium comandrae* Peck.
Cytospora canker	*Cytospora abietis* Sacc. and *C. kunzei* Sacc.
Damping-off	*Fusarium* sp., *Pythium* sp.
Diplodia blight	*Diplodia pinea* (Desm.) Kickx.
Douglas-fir needle cast	*Rhabdocline pseudotsugae* Syd. and *R. weirii* Parker and Reid
Dwarf mistletoes	*Arceuthobium* spp.
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker
Fusarium root disease	*Fusarium oxysporum* Schlect.
Grey mold	*Botrytis cinerea* Pers. ex Fr.
Larch needle blight	*Hypodermella laricis* Tub.
Larch needle cast	*Meria laricis* Vuill.
Indian paint fungus	*Echinodontium tinctorium* E. and E.
Laminated root rot	*Phellinus weirii* (Murr.) Gilb.
Pini rot	*Phellinus pini* (Thore:Fr.) Pilet.
Stalactiform rust	*Cronartium coleosporioides* Arth.
Western gall rust	*Endocronartium harknessii* (Moore) Hirat.
White pine blister rust	*Cronartium ribicola* Fisch.

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